PATENT SPECIFICATION

(11) 1 283 067

DRAWINGS ATTACHED

1 283 067

(21) Application No. 37746/69 (22) Filed 28 July 1969
(31) Convention Application No. 750 300 (32) Filed 5 Aug. 1968 in
(33) United States of America (US)
(45) Complete Specification published 26 July 1972
(51) International Classification B32B 31/12 5/18 7/14 27/10 27/40
(52) Index at acceptance
B5N 171 17X 17Y 211 227 22Y 238 250 252X 252Y 253Y 254X 254Y 255X 255Y 258X 270X 273X 298Y 322Y 326Y 344 355 55X 598 60Y 625 626 638 641 669 670 674 679 68X 69X 715 71X 726 741 758 774 794 807

(54) IMPROVEMENTS IN AND RELATING TO RESILIENT SHEET MATERIAL

(71) We, KIMBERLY-CLARK CORPORATION, a corporation organized under the laws of the State of Delaware, United States of America, of Neenah, Wisconsin, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to cellulosic paper sheet materials useful in a wide variety of product applications such as washcloths, insulation, toweling, coverings, disposable garment material and the like.

Absorbent papers are generally relatively soft, loosely felted, bibulous and are used as toweling, blotters, and the like. Commonly, these papers have a wet strength treatment which serves to aid in the retention of paper strength when wetted without unduly affecting the paper absorbency characteristics. Cellulosic wadding is one well-known form of such absorbent paper and is itself characterized by a crepe structure and very generally a basis weight, after creping from a Yankee drier or the like, of about 7 to 13 pounds per 2880 sq. ft., for example. Such papers for many applications lack, particularly when wetted, the degree of toughness necessary to make the paper commercially desirable under circumstances which involve severe manual or mechanical action.

In accordance with the invention resilient sheet material comprises a layer of absorbent paper and a ply of elastomeric fluid-retentive foam film material which has been bonded whilst in a stretched state to the absorbent paper only at spaced zones, the foam film material having a thickness greater than that of the absorbent paper. We have found that the physical properties of absorbent paper and the like in accordance with the invention may be improved in applications involving wrinkling, twisting, balling up, stretching, tortion action and the like. The elastic foam exerts a compressive force on the paper in the longitudinal direction and plane of the paper and imparts to the composite product not only elasticity in the planar directions of the sheet material, but also a compressibility and resiliency in a direction perpendicular to the sheet. This resiliency appears largely to be influential in achieving the desired toughness for many applications without adversely affecting product absorbency.

The sheet material may be made by a method comprising stretching a sheet of foamed material, applying adhesive in spaced zones either to the foamed sheet or to a sheet of absorbent paper, applying the paper to one or both sides of the foam sheet whilst retaining the foam sheet in its stretched condition and finally allowing the foam sheet to retract.

Products in accordance with the invention have resiliency in the direction perpendicular to the sheet plane, the so-called Z direction, have been found to possess the improved characteristics to such extent that, though in the general province of disposable items, they are, in fact, reusable a number of times and may be subjected, for example, to machine washing. Additionally, the material of the invention in the dry state is conformable, crumpleable, exhibits a good hand, and has a retentive memory; the dry surface characteristics are of particular importance in many applications and the products may be of significant utility where intimate contact with the human skin is involved, as the product may have a soft and pleasant texture, absorbency and breathability. Particularly also, crepe tissue products when made in accordance with the invention and when wetted as in washcloth or toweling use, for example, exhibit a distinct memory for the dry state condition.

[Price 25p]

By this we mean that there is not a particularly significant change upon wetting the product and re-drying the thoroughly wetted product.

Foams which are useful include the open celled polyurethane materials and others such as polyvinyl chloride and synthetic and natural latices. The foam not only serves to provide Z direction resiliency but contributes to some extent in water retention by holding water apparently within the pores of the elastomeric body; the hydrophobic nature of the foam, however, aids in water release under manual pressure. Further, the foam appears to have an insulative function which inhibits, for example, too rapid cooling of a sheet which has been wetted with warm water so that utility of the material as a washcloth and similar materials is enhanced.

Generally, a composite sheet or laminate in accordance with the invention may be formed by stretching out the foam, applying adhesive in spaced zones to either the foam or the absorbent paper and laying the absorbent paper on one or both sides of the foam while the foam is elastically stressed; release of the foam permits foam return toward its original condition depending upon the resistance of the absorbent paper. In instances where the absorbent paper is a creped sheet, the recovery of the foam may be nearly 100% and the creped sheet then becomes compressed longitudinally to a considerable degree. The adhesive in the spaced zones holds the paper and foam together while permitting bulking of the sheet in the areas between the adhesive zones; such bulking of paper sheets improves absorbency, softness, and the hand or feel of the product.

Absorbent papers having a degree of longitudinal rigidity, such as uncreped absorbent paper, may oppose the action of the stretched foam and inhibit its return; under this condition we have found that simply wetting the paper with water or other polar material will reduce the paper resistance and trigger the foam release; this will, in effect, shrink the composite, developing in the absorbent paper irregular patterns influenced to some degree by the nature of the adhesive pattern but exhibiting also the effects of stresses built into the sheet during its manufacture and released by the wetting treatment.

The foam material is in film form, very extensible and flexible, and of greater thickness than each paper web so that it gives significant body to the composite. The film is of generally low strength, however, and of itself does not bond well to the absorbent paper webs. It may be air permeable.

The invention will now be further described by way of example with reference to the accompanying drawings in which:—

Fig. 1 is an elevation of one form of production apparatus suitable for the manufacture of products of the invention;

Fig. 2 is a fragmentary view of a patterned roll for the application of an adhesive pattern;

Fig. 2A is a fragmentary view of a roll similar to that of Fig. 2 but showing another form of adhesive pattern;

Fig. 2B illustrates yet another form of patterned roll for the application of adhesive;

Fig. 3 is a view of one embodiment in accordance with the invention illustrating a low bulk corrugated pattern;

Fig. 4 is a view of a more bulky and random pattern; and

Fig. 5 is a view of apparatus useful in a further embodiment of the invention.

Example 1

Polyurethane foam of open cell construction and of a thickness of approximately 0.042" is provided in pre-stretched roll form as indicated by the numeral 1 in Fig. 1. This pre-stretched polyurethane foam is commercially available material and will retain its pre-stretched condition while in roll form. The pre-stretching of the foam may be effected in one convenient way by rewinding a foam sheet on a conventional rewinder with enough tension on the unwind roll to give the desired stretch in the finished wind-up roll. The elastomeric foam will regain its original condition and substantially the same dimensions when unrolled in the absence of tension. This stretch, that is, the pre-stretch in the specific example under discussion, was about 20% based on the original foam length.

Shown also in Fig. 1 is suitable apparatus for the production of laminates or composites in accordance with this invention. Generally indicated by the numeral 2 is a calender stack provided at a short distance from the pre-stretched polyurethane foam roll 1. This calender includes rolls 3, 4, 5 and 6 in superposed position and defines nips 7, 8 and 9. On the side of the calender stack remote from the polyurethane roll 1 are wind-up rolls indicated generally at 10, each roll being specifically designated as 11, 12. In Fig. 1 the numerals 13 and 14 indicate rolls of creped wadding, the upper roll being indicated at 13. As roll 13 is unwound, the wadding 15 is fed over an adhesive applicator roll 16 to nip 7 of the calender stack. The adhesive applicator roll is itself a steel cylinder and is fed by a patterned pond roll 18 partially immersed in pond 19 and rotating in the direction indicated by the arrow. Blade 20 serves to remove excess adhesive as the adhesive is carried to the nip 21 formed between the

applicator and pond rolls. In the present instance the pattern of adhesive applied by rolls 18 and 16 to the traveling cellulosic web is a brick pattern illustrated in Fig. 2 of the drawings. Such a pattern provides on the roll well spaced adhesive carrying zones 24, and the applied adhesive areas on the web are then separated to a significant degree though the wadding will be well bonded to the foam.

The lower cellulosic wadding web 23 is passed from roll 14 over a similar adhesive applicator station 22 which is not described in detail as it corresponds substantially identically with that previously mentioned. The wadding web 23 is directed to nip 9 of the calender stack.

The wadding, in accordance with this embodiment of the invention, has a basis weight of about 13 pounds per 2880 sq. ft. and is wet strengthened by the inclusion in the paper of about 1.5% of a polyamide-epichlorohydrin resin of conventional nature. The crepe is such as to provide hills and valleys extending transversely of the sheet length, and the sheet has an overall thickness of about 0.008″. The calender stack composed of rolls 3, 4, 5 and 6 includes smooth, hard rolls 4, 6 of tetrafluoroethylene resin on a steel shell. Rolls 3, 5 are suitably silicone covered having a Shore A durometer of about 65—70 and they are not heated. The rolls 4, 6 are maintained at a temperature of about 330°F. in the embodiment of the invention to provide for tackiness in the adhesive in the laminating step as noted hereinafter. The calender thus exerts a somewhat resilient pressing action on the material in the nips while providing heat for inducing adhesive action where such heating is necessary, as in the instances of plastisols or thermoplastic adhesives.

The web 15 and the web 23 are united with the stretched polyurethane in the nip 9. If desired, the foam could be directed to nip 7 and first united with web 15, followed by uniting with web 23 at nip 9. The adhesive is carried by the creped wadding webs in the pattern determined by the rolls (Fig. 2) of the applicator and, in this instance, is a plastisol and is heat settable. The adhesive on the web 15 is partially set as it passes over heated roll 4; the adhesive on sheet 23 is partially set by the heat of roll 6. The adhesive, by the partial setting action, becomes non-fluid but quite tacky and adheres well to the traveling polyurethane sheet in the combining nip 9. The polyurethane foam sheet at this time is still maintained in a stretched condition by the drawing action of rolls 5, 6 and the restraining action of the supply roll 1 which may be braked in known manner, if desired. The wind-up 10 suitably is operated more slowly than the calender rolls and this permits the polyurethane to retract as it passes from nip 9 to the wind-up position of rolls 11, 12; such tension release causes longitudinal retraction of the elastomeric foam sheet against the crepe wadding and provides a macro-crepe structure in each of the crepe wadding webs.

In the event that uncreped paper sheets are employed in conjunction with the foam, generally the resistance offered by the sheets will largely or completely prevent the shrinkage of the foam while the paper sheets are dry. Wetting of the paper will, however, cause a drop in the resistance and bulking or macro-creping if spaced adhesive zones are employed to retain the web and foam together.

The bulking of the crepe wadding, in effect, results in a macro-crepe structure where the adhesive is disposed in spaced zones. The extent of the macro-crepe and its particular nature are dependent respectively upon the spacing between adhesive zones and the adhesive zone configuration. In this instance illustrated by the brick pattern in Fig. 2, the adhesive zones are relatively large, relatively close together and in the shape of rectangles. Such results in a macro-crepe structure but one which is of relatively low bulk as that compared to a product produced by the relatively open diamond adhesive pattern of Fig. 2A. The brick pattern provides a macro-crepe which is fairly regular and resembles a deep corrugate with substantially continuous hills 25 and valleys 26 extending transversely of the sheet 27 (Fig. 3). In effect, the product of the brick pattern is one in which the crepe wadding tissue is adhered to the polyurethane foam securely in the area enclosed by a brick-shaped or rectangular area while adjacent areas corresponding to zones 28 of the roll, and particularly between rows 29 (Fig. 2), are bulked up considerably. The horizontal spacings (Fig. 2) between adhesive carrying zones, when relatively small as in Fig. 2, do not, in the corresponding product, bulk appreciably and appear to the unaided eye to form with the adhesively retained zones the continuous transverse valleys 26 (Fig. 3).

The product (Fig. 3) in effect has a macro-crepe imposed on the usual crepe induced in the original sheet formation action. Some of this latter crepe indicated at 30 in Fig. 3 may be changed in amount and contour when the product is wetted; specifically, the crepe indicated at 30 may be lost and the bulk increased upon re-drying. However, the macro-crepe being formed (Fig. 4) by wadding web areas which are free of the foam film largely determines the sheet bulk and changes in the original creped structure,

upon wetting, are not significant in most product applications.

The product illustrated and described (Fig. 3) is capable of picking up about four times its own weight of water. Such pick-up may be achieved using in the composite the wet strengthened absorbent paper mentioned above, and the product retains its integrity upon re-drying; tests have indicated the product to be sufficiently tough to withstand repeated wetting, wringing out and drying. In this connection it is to be noted that the foam material, while capable of retaining water and co-acting with the absorbent paper for this purpose, also releases or draws off water under applied stress; thus, the product has utility as a washcloth, toweling and the like. Further, the macro-crepe structure, whether corrugate or otherwise, provides some surface roughness, and the tendency of some materials to slipperiness in the presence of soap and water is minimized.

EXAMPLE 2

Example 1 was repeated except that a diamond adhesive pattern (Fig. 2A) was applied to the cellulosic wadding web 23[1] and web 15[1] rather than the brick pattern, the adhesive zone arrangement being indicated at 24a (Fig. 2A). The diamond adhesive pattern is more symmetrical in the plane of the sheet than the brick pattern and provides for better foldability of the product with the foam 1[1] (Fig. 4) in all directions relative to the brick pattern which is quite oriented (Fig. 3). Specifically, the brick pattern product does not fold as well transversely of the sheet as does the diamond patterned material. The diamond pattern as to foldability is also more universal than the line adhesive pattern illustrated at 24b in Fig. 2B.

EXAMPLES 3—6

Example 1 was repeated but different stretches in the initial pre-stretched polyurethane material were employed. The polyurethane film has an initial thickness of about 0.042″ and each crepe wadding web a thickness of about 0.008″. The results of these tests are illustrated in the following table:

Example	Initial Foam Stretch	Composite Dry Stretch (To Failure)	Composite Wet Stretch (To Failure)
3	6%	28.3%	33.9%
4	11%	30.0%	38.6%
5	17%	46.4%	58.4%
6	28%	52.8%	64.8%

The column designated "initial foam stretch" sets out the % of stretch imparted to the foam itself before wadding lamination. This % stretch also represents the length of paper or crepe wadding present in excess in the product over that of normal paper sheet length.

It will also be noted that the composite dry stretch and composite wet stretch to failure data refer to crepe cellulose wadding failure and that the per cent of stretch to the failure condition increases materially with the stretch initially imparted. Particularly also, high initial foam stretch increases the product wet stretch and also product toughness and product resistance to failure in the paper layer or layers due to twisting, crumpling and similar actions.

The thickness of the final product upon relaxation of the foam sheet is materially increased over the sum of the individual unstretched components. At about 6% initial stretch (Example 3) the thickness increase is 20 to 25%, and the product of Example 6 has a thickness of about 0.110″ or an increase of about 90%. Such bulk increase materially improves the product hand, softness, absorbency and resiliency characteristics.

EXAMPLE 7

In the previous examples the foam material has been subjected to stretch in only the longitudinal sheet direction for receipt of the absorbent paper. Measurements indicate that in the range of the thicknesses of foam materials specifically under consideration to upgrade the paper properties, the foams have a thickness at least about double that of the uncreped sheet (0.003 to 0.005″) and up to 20 times or more that of the paper. Thicknesses of 0.003″ to 0.008″ crepe wadding are common and foam thicknesses of 0.020″ to 0.050″ quite suitable.

In Fig. 5 there is shown an equipment arrangement somewhat similar to that of Fig. 1 but directed to the utilization of poly-

urethane foam which may be but is not necessarily pre-stretched; stretch is imparted laterally and longitudinally in the operation of the equipment. As illustration there is indicated by numeral 31 a roll of polyurethane material having about a 10% stretch imparted to it prior to rolling.

A tenter frame generally designated at 32 is effective to tension the web both longitudinally and laterally. The roll 31 is equipped with an adjustable brake mechanism 34 to restrain the roll and the foam material as it is drawn from the roll is retained on opposite edges by endless chain tenter mechanism 33. This chain and its associated equipment is of well-known and of conventional design, forms no part of the present invention and, accordingly, is not described in detail; further, other types of tentering apparatus may be employed. In effect, as the foam sheet material proceeds to the lamination zone, the chain mechanism draws and spreads the foam material continuously so that the sheet dimensions are increased in both the X and Y planar directions. The longitudinal stretch may be increased to 20% or 30% and the lateral stretch may also be 20% or 30% greater than the original dimension. The wadding sheets in this instance may be the same as in Example 1, and bonding is effected in the same manner; the Z direction resiliency is increased significantly due to the greater bulking upon release of the foam.

It is to be noted that in this instance the foam material has been described as subjected to several and separate longitudinal stretching actions. This is sometimes convenient if the capacity of equipment is limited.

Example 8

The foam sheet material is stretched out as in Example 1. To the sheet material there is laminated an uncreped tissue sheet; this sheet, except for the lack of crepe, is as provided in Example 1, and a sheet is provided on each side of the foam material. In this instance, however, it was found that the resistance of the sheet to lengthwise compression on leaving the calender nip (Fig. 1) was sufficient to prevent any macro-crepe action. The absorbent paper, in fact, remained quite flat. However, upon wetting the product with water, the influence of the stretched foam was sufficient to cause the paper to be retracted and to bulk somewhat though not greatly in the non-adhesive areas. This bulk is retained upon re-drying.

In the practice of the invention water-insoluble or water-resistant adhesives are preferable in the product though, in some cases, a water-soluble adhesive may be tolerated. A preferred adhesive is a plastisol of 100 parts of polyvinyl chloride dispersed in 60 parts by weight of diisodecyl phthalate: such material has a viscosity of about 3000 centipoises Brookfield as measured with a No. 4 spindle at 20 rmp. It is readily applied by roll means and the viscosity may be readily adjusted by solvent or plasticizer addition to accommodate a particular situation. Preferably, the viscosity is maintained sufficiently high as to inhibit flow on or significantly into the crepe wadding or absorbent paper; the adhesive is not generally visible to the eye in the products. The amount of such plasticol adhesive as described applied to retain one wadding sheet on the foam is about 5.5 grams per square yard.

Other adhesives such as the polyvinyl resins, plasticized or unplasticized, polyvinyl acetate and acrylics such as the alkyl acrylate resins serve the purpose well. In general, it is desired to maintain the adhesive quantity used low and well dispersed as adhesive is costly and, when employed in excess, tends to stiffen the product.

The products, as noted, have utility as washcloths, facecloths, toweling, insulation, lining, as a material for dresses, and the like. The soft, conformable surface renders the product an excellent bed sheet material and, when only one side carries the creped wadding, the non-skid second surface makes for utility as a draw sheet and mattress pad.

WHAT WE CLAIM IS:—

1. Resilient sheet material comprising a layer of absorbent paper and a ply of elastomeric fluid-retentive foam film material which has been bonded whilst in a stretched state to the absorbent paper only at spaced zones, the foam film material having a thickness greater than that of the absorbent paper.

2. Resilient sheet material as claimed in Claim 1 in which the layer of absorbent paper is creped cellulose wadding which has been compressed longitudinally to impose a macro-crepe structure thereon by means of the compressive force ererted by the stretched foam.

3. Resilient sheet material as claimed in either Claim 1 or 2 in which the absorbent paper has in the dry state a stiffness in the plane of the paper sufficient to withstand the compressive force exerted by the stretched elastomeric foam film material, whereby compression of the paper longitudinally by the foam film material is substantially prevented until the paper is wetted.

4. Resilient sheet material as claimed in any of the preceding claims in which the foam material has a thickness at least double that of the absorbent paper material.

5. Resilient sheet material as claimed in any of the preceding claims in which the ply of elastic fluid retentive foam film

material has a layer of absorbent paper on each side thereof so that the film material extends between and separates the absorbent paper layers, and adhesive in spaced zones on opposite sides of the film material retains the absorbent paper layers so that the film material is securely joined to the paper layers only at said spaced zones.

6. Resilient sheet material as claimed in any of the preceding claims in which the absorbent paper is creped cellulose wadding and a layer of such wadding is bonded on each side of the elastomeric foam film material, the compressive force exerted by the foam material being effective to compress the wadding and bulk the composite so that the composite thickness is about 20% to 90% greater than the sum of the individual thicknesses of the unstretched components forming the composite material.

7. Resilient sheet material as claimed in any of the preceding claims in which the bonding of the absorbent paper and foam film material as spaced zones is by a pattern of adhesive which does not substantially penetrate the paper.

8. Resilient sheet material as claimed in either of Claims 2 or 6 in which the crepe cellulose wadding has a basis weight of between about 7 and 13 pounds basis per 2880 sq. ft., and the foam film material has a thickness of between about 0.020" and 0.050".

9. Resilient sheet material as claimed in Claim 8 and in which a crepe cellulose wadding sheet is bonded on each side of the elastomeric foam material and the crepe cellulose wadding sheets are each of between about 7 and 13 pounds basis weight per 2880 sq. ft.

10. A method of manufacturing sheet material as claimed in any of the preceding claims comprising stretching a sheet of foamed material, applying adhesive in spaced zones either to the foamed sheet or to a sheet of absorbent paper, applying the paper to one or both sides of the foam sheet whilst retaining the foam sheet in its stretched condition and finally allowing the foam sheet to retract.

11. A method as claimed in Claim 10 in which the paper sheet is wetted.

12. Resilient sheet material substantially as hereinbefore described with reference to any one of the examples and/or the accompanying drawings.

13. A method of producing composite sheet material substantially as hereinbefore described with reference to the accompanying drawings.

For the applicants:
LLOYD WISE, BOULY & HAIG,
Chartered Patent Agents,
Norman House,
105—109 Strand,
London, W.C.2.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1972.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY,
from which copies may be obtained.

1283067 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

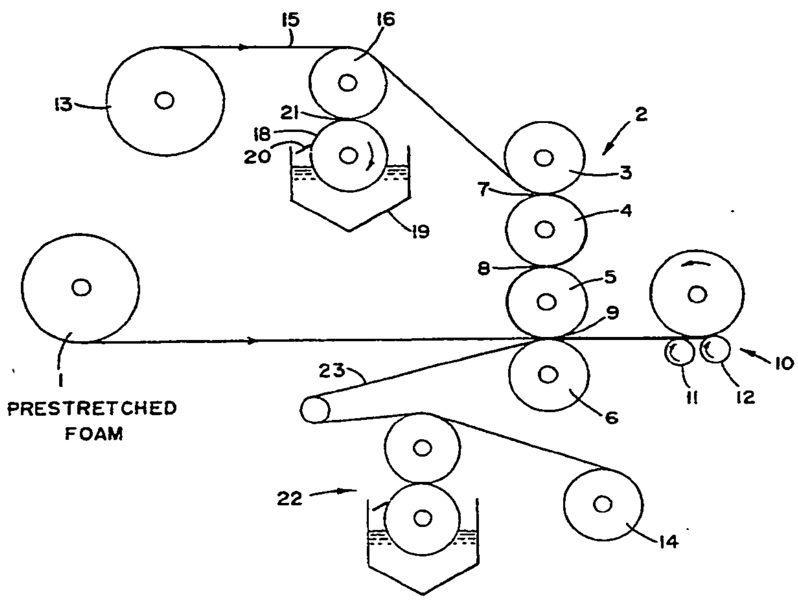

FIG. 1

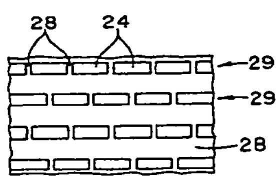

FIG. 2

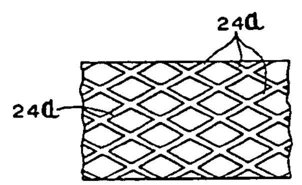

FIG. 2A

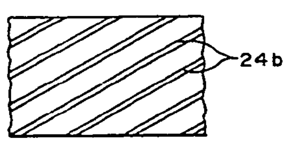

FIG. 2B

1283067 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

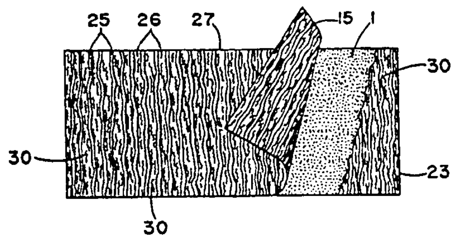

FIG. 3

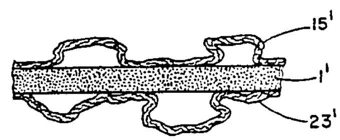

FIG. 4

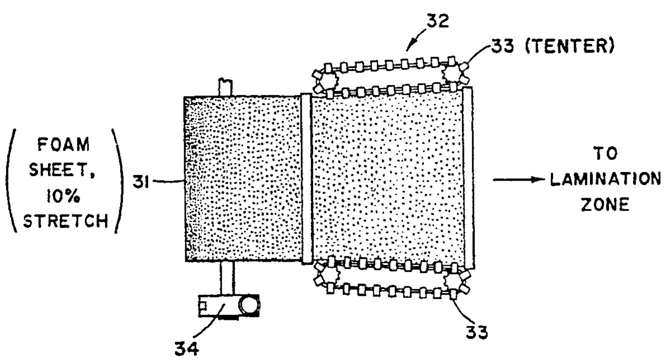

FIG. 5